

REMARKS

Claims 1-20 are amended, and claim 21 is canceled without prejudice or disclaimer. Claims 1-20 are pending.

New paragraphs to the specification are added to pages 8 and 10-11 of the specification, and new Figures 7-8 are added to the application.

The amendments to the figures, specification, abstract and claims are based on the application as originally filed. For example, the new Figures 7-8 are based on the original specification and claims as filed, including page 8, line 21 which recites "a system ... for object recognition ...", page 38, lines 15-20, which recites the use of memory, storage "to disk on systems that support virtual memory", and claims 1-21 as originally filed.

Such recitation in the specification, as originally filed, of memory, disks, and systems with virtual memory clearly refer to known computer systems.

Claims 1-20 are also amended based on the application as originally filed. Therefore, it is respectfully submitted that no new matter has been added with the insertion of new paragraphs to the specification and new drawings in Figures 7-8.

In the office action, claims 7-9, 12, and 21 were objected to in view of informalities in the language. Claim 21 is canceled. Claims 7-9 and 12 have been amended to overcome the objection, so reconsideration and withdrawal of the objection to claims 7-9 and 12 are respectfully requested.

In the office action, the specification was objected to as not providing antecedent basis for the system in claim 19. The specification has been amended as described above

based on the claims as originally filed, including claim 19, as well as other portions of the specification, as described above. No new matter has been added, as described above.

Therefore, claim 19 recites a system which is supported by and has antecedent basis in the specification as amended, so reconsideration and withdrawal of the objection to the specification are respectfully requested.

In the office action, the drawings were objected to under 37 C.F.R. § 1.83(a) regarding the features of claims 19-21. New Figures 7-8 have been added which are based on the claims as originally filed, including claims 19-21, as well as other portions of the specification, as described above. No new matter has been added, as described above.

Since Figures 7-8 are new and are on a separate sheet, and the original Figures 1-6 are not amended or canceled, the new sheet having new Figures 7-8 is not labeled "Replacement Sheet".

Accordingly, reconsideration and withdrawal of the objection to the drawings and entry and approval of new Figures 7-8 are respectfully requested.

In the office action, claim 21 was rejected under 35 U.S.C. § 101 as allegedly directed to non-statutory subject matter.

Claim 21 is canceled, so reconsideration and withdrawal of the rejection of claim 21 are respectfully requested.

In the office action, claims 1-19 were rejected under 35 U.S.C. § 112, second paragraph. Claims 1-19 are amended to overcome the rejection and to clarify the language. Accordingly, reconsideration and withdrawal of the rejection of claims 1-19 under 35 U.S.C. § 112, second paragraph are respectfully requested.

In the office action, it is stated that claims 2 and 4-18 would be allowable if rewritten. Claim 2 is amended to be in independent form and to overcome the rejection under 35 U.S.C. § 112, second paragraph, so claim 2, as amended, is allowable.

Claims 4-18 depend from claim 2, so claims 4-18 include the recitation of allowable claim 2. Therefore, claims 4-18 are also allowable.

Therefore, allowance of claims 2 and 4-18 are respectfully requested.

In the office action, claims 1, 3, and 19-21 were rejected under 35 U.S.C. § 102(b) in view of the article, Cootes et al., "Multi-Resolution Search with Active Shape Models".

Claim 21 is canceled, without prejudice or disclaimer.

Independent claim 1 is patentable over Cootes et al. since Cootes et al. does not disclose or suggest all of the elements, steps, and features of the claimed invention. Cootes et al. describes generating a model by hand, such as in section 4 of Cootes et al. which recites "we trained a face model using 169 landmark points planted by hand on 11 images of a single person's face". Such a hand-generated geometric model may be arbitrary and inexact.

In addition, in Cootes et al., on the training images, only a grey-level statistic along a profile perpendicular to the boundary of the model is calculated, as described in section 2, last paragraph of Cootes et al. The statistic model of the poses of the model points in Cootes et al., if a statistic model even exists at all, may also be calculated from the model poses input by hand in the training images.

On the contrary, the present invention automatically generates the model from an image of the model object by image processing methods.

Furthermore, the model of Cootes et al. consists of points, each of which can move along a line perpendicular to the contour of the model, and an associated grey-level model or grey-level profile.

Since the points are specified by hand in Cootes et al., step (c) of claim 1 is not present in the method of Cootes et al.; that is, Cootes et al. does not have "said points and direction vectors being generated by an image processing operation that returns a direction vector for at least each model point", as in claim 1. At least, Cootes et al. lacks any disclosure or suggestion that the direction vectors are generated by an image processing operation. How the direction vectors perpendicular to the contour are calculated, if at all, in the method of Cootes et al. is not described or suggested in Cootes et al.

However, it is clear that the method in Cootes et al. does not use image processing to calculate such direction vectors, if at all.

Furthermore, the modeling of the object in Cootes et al. compared to the present invention is substantially different. In Cootes et al., each model point can move perpendicular to the contour of the model independent from the other model points. Thus, three co-linear points in Cootes et al. can change to a "V". This is not the case with the method according to the present invention, in which affine or projective projections are used so that co-linear points must stay co-linear. Thus, a completely different class of transformations is used in the present invention than in the method of Cootes et al.

In addition, Cootes et al. does not disclose or suggest step (f) of claim 1. The movement of the model points does not imply, in any way, that the direction vectors are extracted from the search image. Even more, this is not done in Cootes et al. The

movement direction of the model points are actually stored in the model. Cootes et al. compares grey levels, and thus, the method of Cootes et al. is not robust against illumination changes.

On the contrary, according to the present invention, for each point on each discretization level of the search space; for example, on each pyramid level, a direction vector is calculated; that is, for each pixel that is within the search space of the translations. This is substantially different from Cootes et al.

Regarding step (g) of claim 1, the metric used by Cootes is divided into two parts: for localization of the individual points, a grey-level metric is used but which is not described in detail (see FIG. 2). The positions resulting therefrom are compared with an expected position. It is to be noted that this requires a model for the permissible movements of the individual points which is also not described in Cootes et al. apart from a reference to "statistically based flexible models" in Section 1. After this, it is counted how many points are within the required tolerances. This is a substantially different metric compared to that used according to the present invention and to what is meant by "computing a match metric that uses the direction information of the model and the transformed image for all possible poses of the model in the coarsest discretization level of the search space" in the claimed invention. Of course, it could be argued that the metric of Cootes et al. uses the direction formation perpendicular to the contour. However, as described above, since no direction information is used from the search image, step (g) of claim 1 is not present in Cootes et al.

Furthermore, Cootes et al. does not suggest that the metric is calculated for all points in the coarsest discretization of the search space; for example, on the uppermost

level of the pyramid for all rotations and scaling. Even in contrast thereto, some kind of method of steepest descent is used which tries in an iterative process to improve the model position (see items (i) and (ii) in section 2 of Cootes et al.). This is substantially different from the method of the present invention. As can easily be seen from section 5 of Cootes et al., the correct position is only found if the start position is within a very small area around the actual position in the search image; for example,  $\pm 80$  pixels. This is not the case according to the method of the present invention since for the coarsest discretization, all transformations are checked.

In order to clarify this point; that is, that the direction information from the model and from the search image is inherently used to calculate the metric, step (g) may involve, for all possible poses of the model in the coarsest discretization level of the search space, computing a match metric that is based on the direction vectors of the precomputed model and the direction vectors of the transformed image. The metric of Cootes et al. is completely different from the metric according to the present invention.

Regarding step (h) of the present invention, Cootes does not calculate the metric for all relevant points in the coarsest discretization of the search space; for example, for the uppermost level of the pyramid for all rotations and scalings, as in the present invention. In addition, all poses corresponding to a point in the discretization of the search space are determined in the present invention at which the metric is sufficiently high and which are locally maximal; that is, all poses that are possible instances of the models which satisfy these two criteria are added to the list of poses which are then to be considered.

This does not take place in the method of Cootes et al. First, the method of Cootes et al. can only find one model instance in the image. Furthermore, according to Cootes et al., for each individual profile, a grey-level metric is calculated and minimized and thus the position of each individual point is determined. For the model as a whole, there is no hint in Cootes et al. that the metric is locally maximized. Cootes et al. merely checks whether the number of point positions which are within the geometrical tolerances is greater than a percentage of the points. Thus, in Cootes et al. there is no test for the model according to which the local optimality of the model is checked, as in the present invention.

Regarding step (i) of claim 1, according to Cootes et al., only one model instance can be found, and so the claimed feature of step (i) in claim 1 is also not present in Cootes et al., since the present invention considers a plurality of instances.

Regarding step (j) of claim 1, since Cootes et al. can only find a single model instance, Cootes et al. is substantially remote from the subject matter of the present invention.

For the reasons set forth above, one having ordinary skill in the art would not look to Cootes et al. for the claimed invention in claim 1, since Cootes et al. is incapable of performing every step to provide the advantages and features of the present invention to more accurately and automatically perform object recognition of a model object in an image, as in claim 1. Accordingly, claim 1, as amended, is patentable over Cootes et al.

Claims 3 and 19-20 depend from claim 1, and so include all of the recitation of claim 1. Since claim 1 is allowable, claims 3 and 19-20 are also allowable.

Therefore, reconsideration and withdrawal of the rejection of claims 1, 3, and 19-21 under 35 U.S.C. § 102(b), and allowance of all pending claims 1-20 are respectfully requested.

Accordingly, entry and approval of the present amendment and allowance of all pending claims are respectfully requested.

In case of any deficiencies in fees by submission of the present amendment, the Commissioner is hereby authorized to charge such deficiencies in fees to Deposit Account Number 01-0035.

Respectfully submitted,



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IN THE DRAWINGS:

Please add new Figures 7-8 on the attached new sheet of drawings.